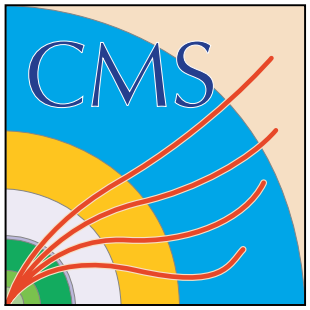
# Introduction to the Phase 2 Tracker Upgrade




Andreas Mussgiller
CMS Tracker Upgrade Meeting
20 December 2011

HELMHOLTZ ASSOCIATION

DESY

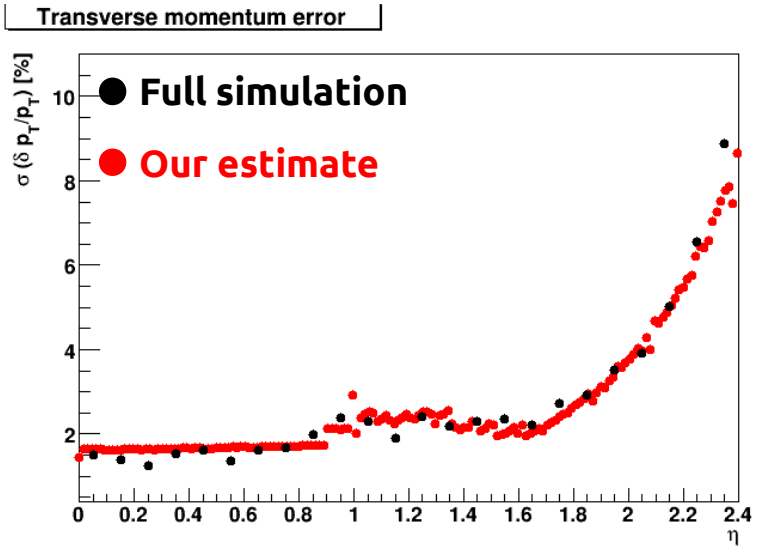
# Outline

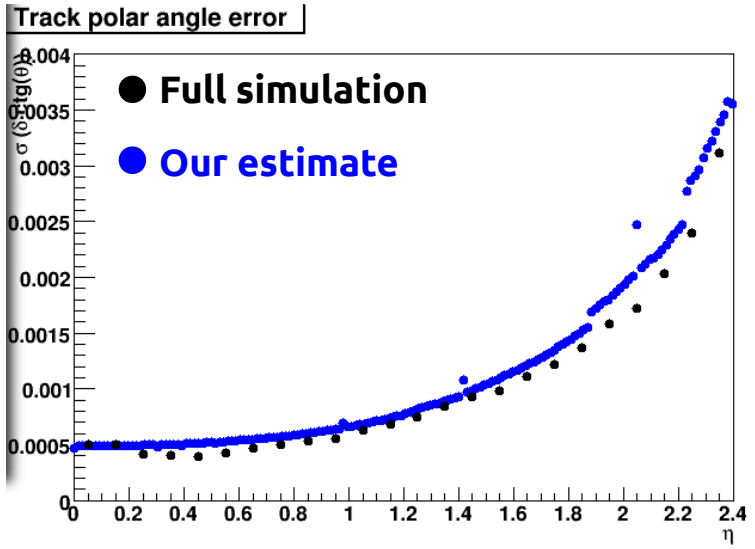
- Tracker Layout
- Module Design




# Tracker Layout Tool

- Design studies performed by Stefano Mersi
- tkLayout - developed by Nicoletta de Maio and Stefano Mersi
  - places modules in 3D space
  - assign material to volumes (with different categories)
  - estimate tracking performance
  - allows for a quantitative comparison of layouts
  - used to optimize tracker layouts
- No Monte Carlo, no track fit



# Tracker Module Options

- Currently two module design options are considered

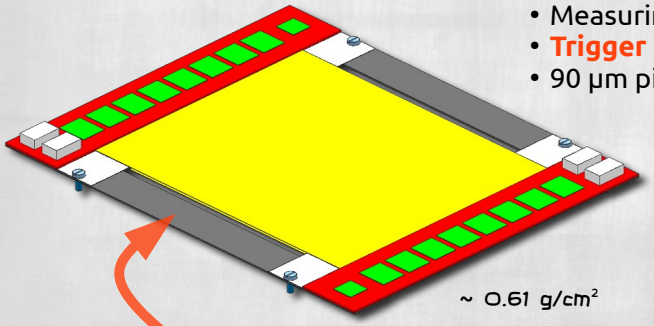
## 2 Strip pT module

13

2S: 2 paired strip sensors

- Works well in the outer part

- Sandwich of **strip sensors**
- 5 cm long strips
- Measuring pT locally
- **Trigger output**
- 90 µm pitch



~ 0.61 g/cm²

GBT + DC/DC for each module

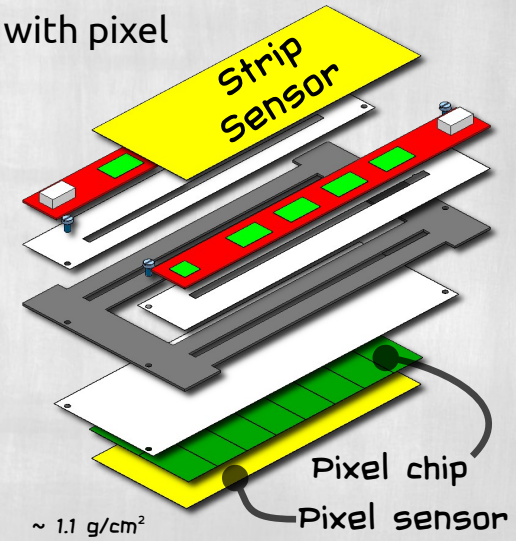
Reasonably detailed model of material

## Pixel + Strip pT module

14

PS: Strip sensor paired with pixel

- Can work in the inner part
- Provides z information in the trigger
- Simple interconnection technology
- Relatively lower power & mass
- Tunable sensors spacing
- 100 µm pitch
- Less than 10 cm × 5 cm

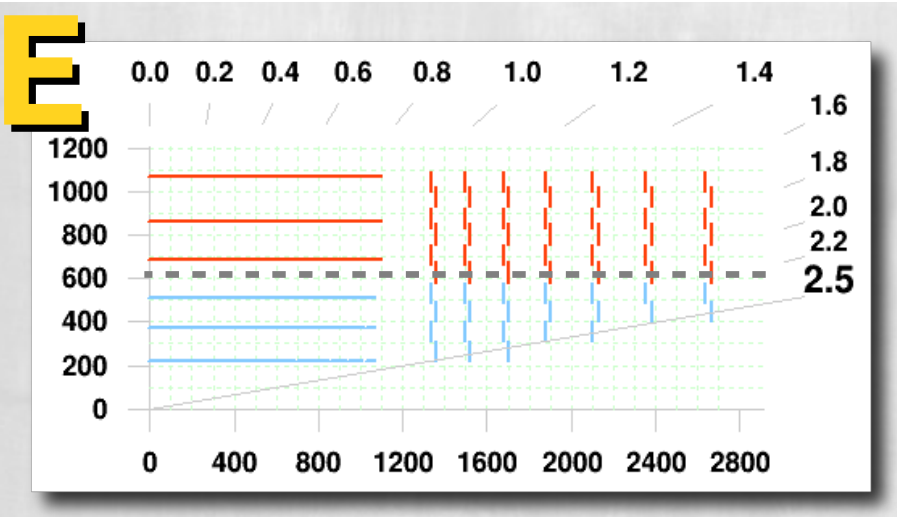


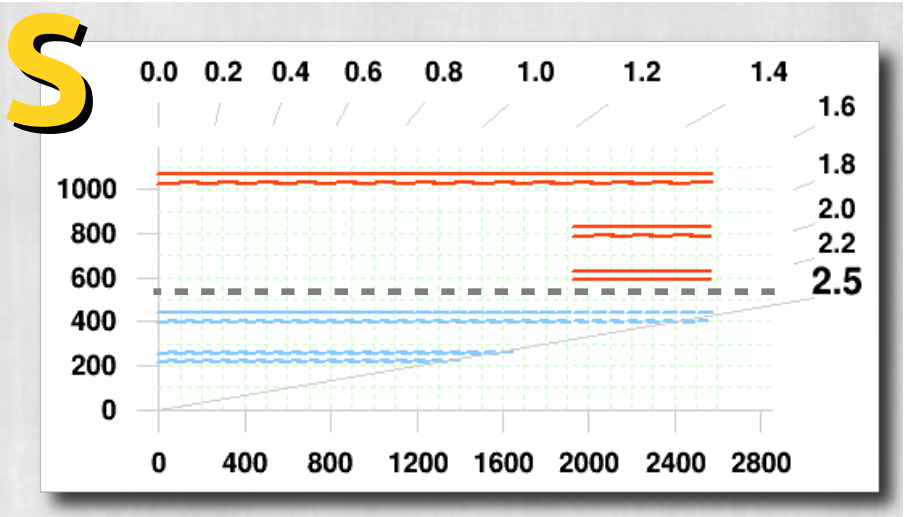

~ 1.1 g/cm²

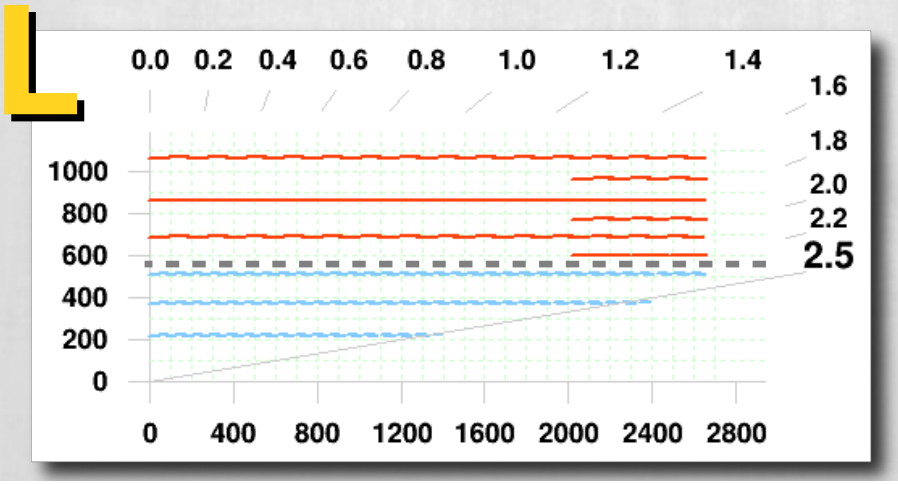
- Both modules allow for a local pT measurement and trigger output for L1
- PS Module provides z information

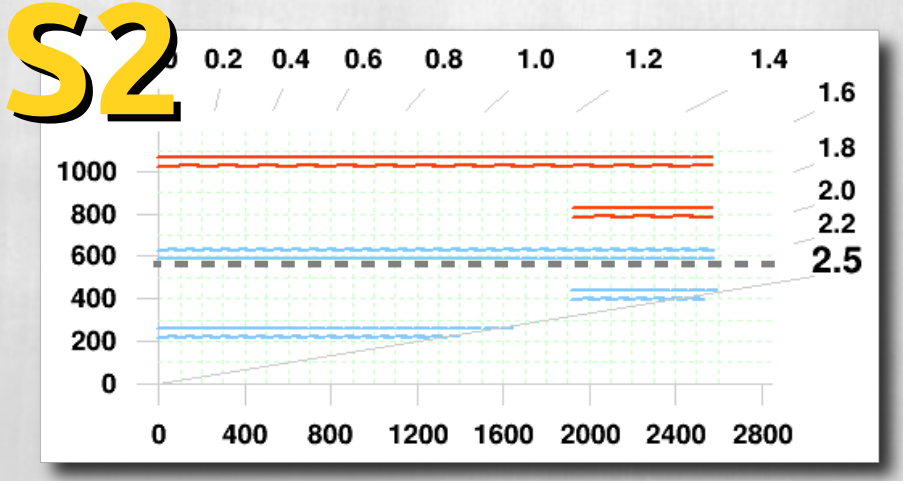
# Tracker Layout Options

- PS modules up to r = 60cm
- 2S modules for r > 60cm

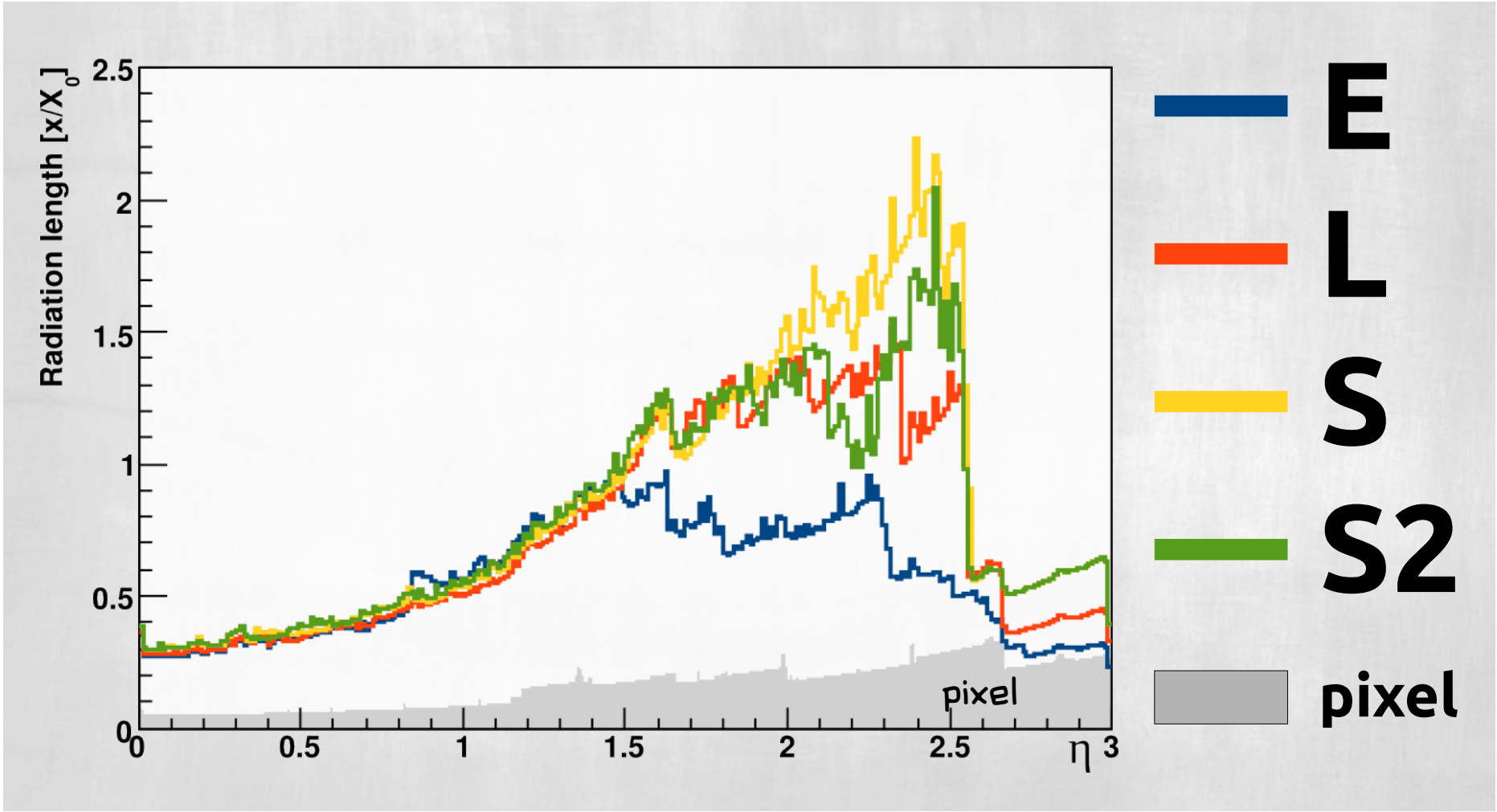


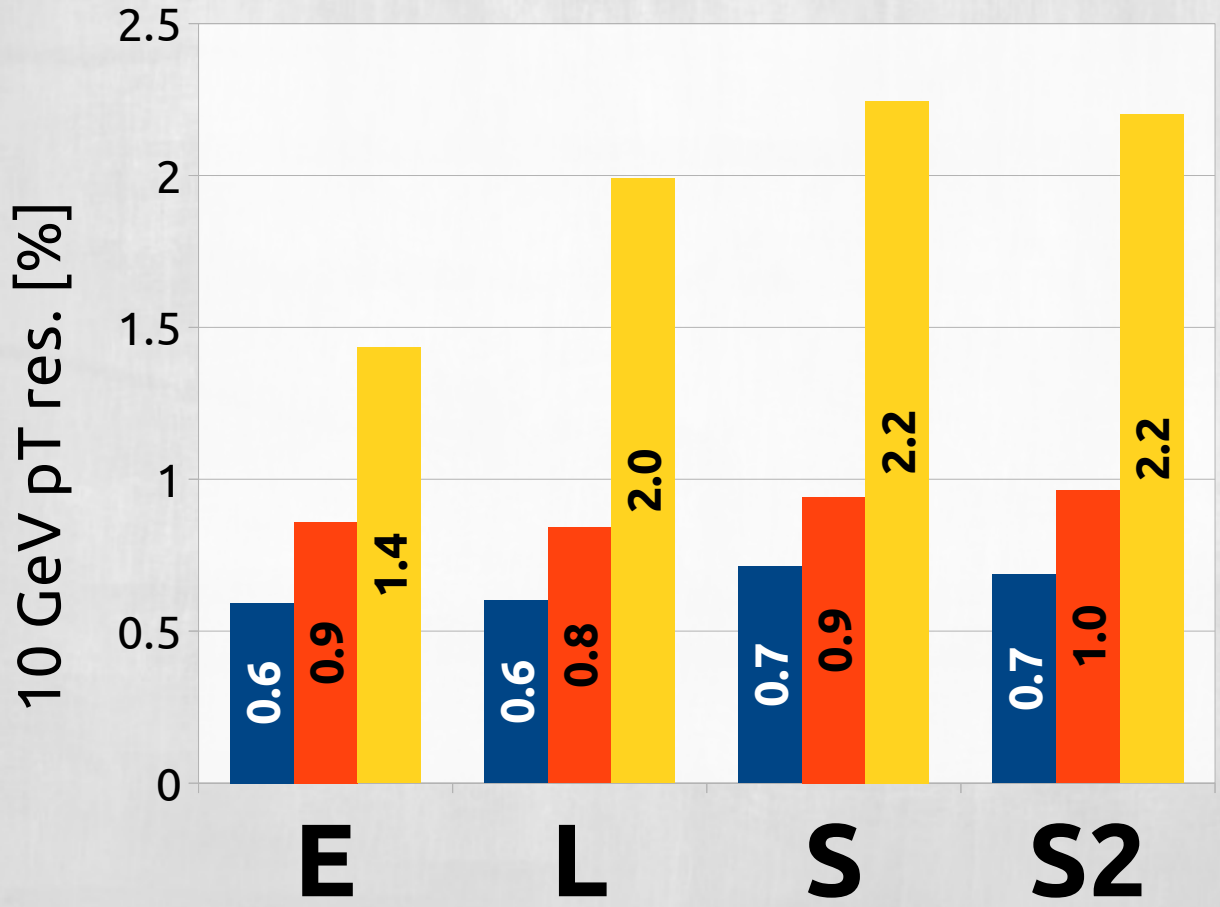



# Material Budget



# Tracking Resolution

## Transverse momentum (10 GeV)

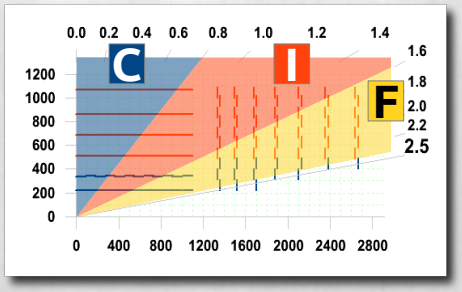



η

C 0 → 0.8

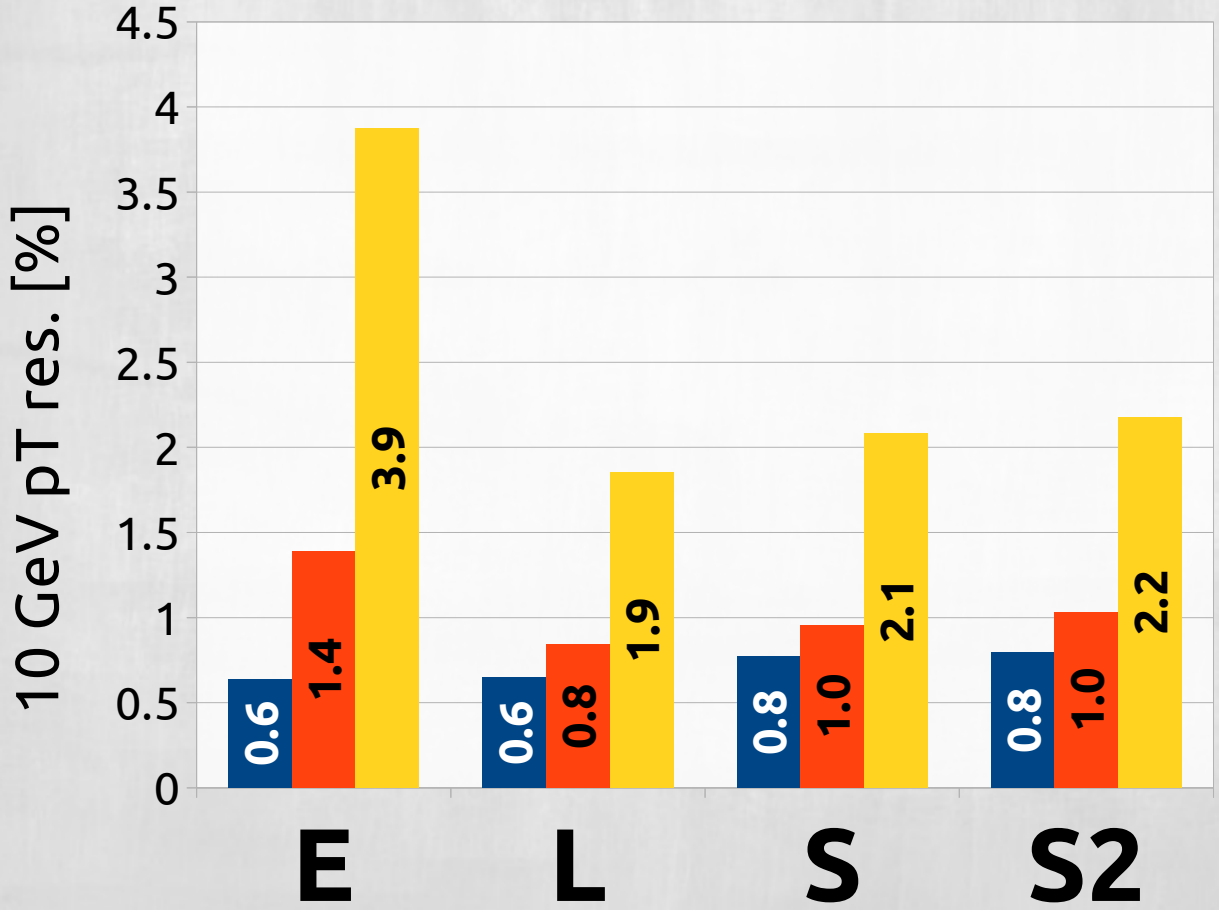
I 0.8 → 1.6

F 1.6 → 2.4



# Trigger Resolution Potential

## Transverse momentum (10 GeV)

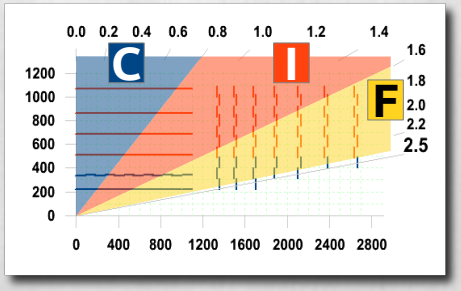



η

C 0 → 0.7

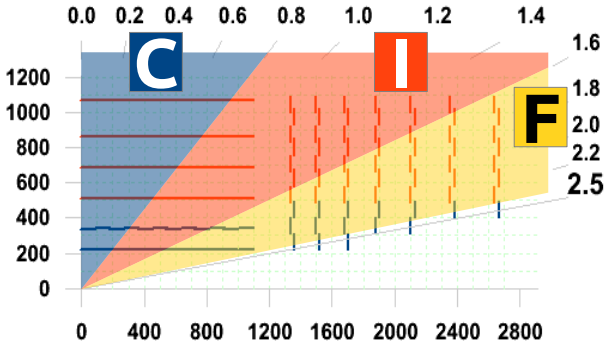
I 0.7 → 1.4

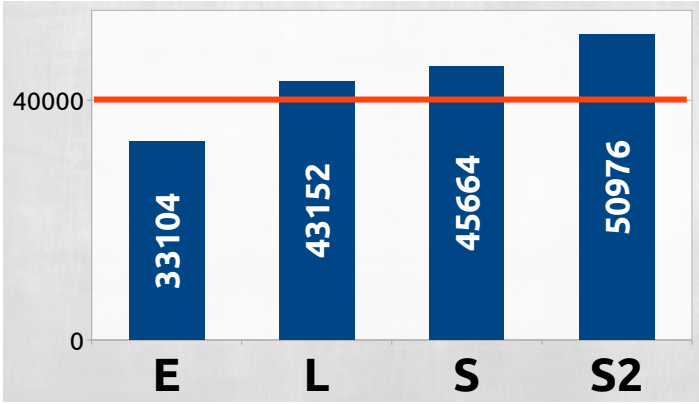
F 1.4 → 2.1



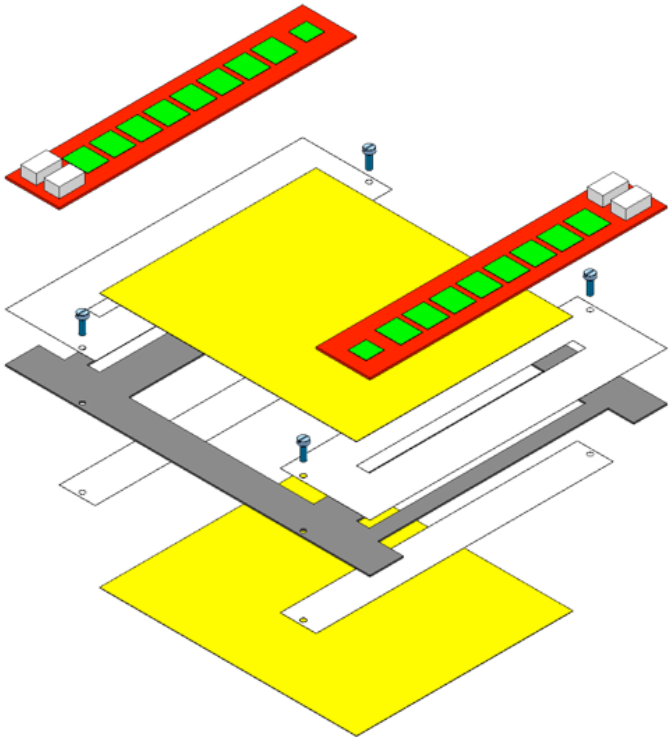
# Tracker Layout Options Summary

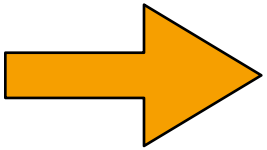
- Tracking
  - central and intermediate region have similar performance
  - forward region favours the layout with end-cap
- Trigger - pT
  - central region insensitive to layout
  - intermediate region favours the unstacked barrel-only layout
  - forward region favours barrel-only layouts
- Trigger - longitudinal impact parameter
  - z-resolution of 7mm in central and intermediate region for all layouts
  - forward region favours stacked barrel-only, then barrel-only and then end-cap layout
- Other considerations
  - barrel-only layouts have twice the amount of material in the forward region
  - Number of modules is higher for barrel-only layouts
  - too many fibres needed for barrel-only layouts and one fibre/GBT per module

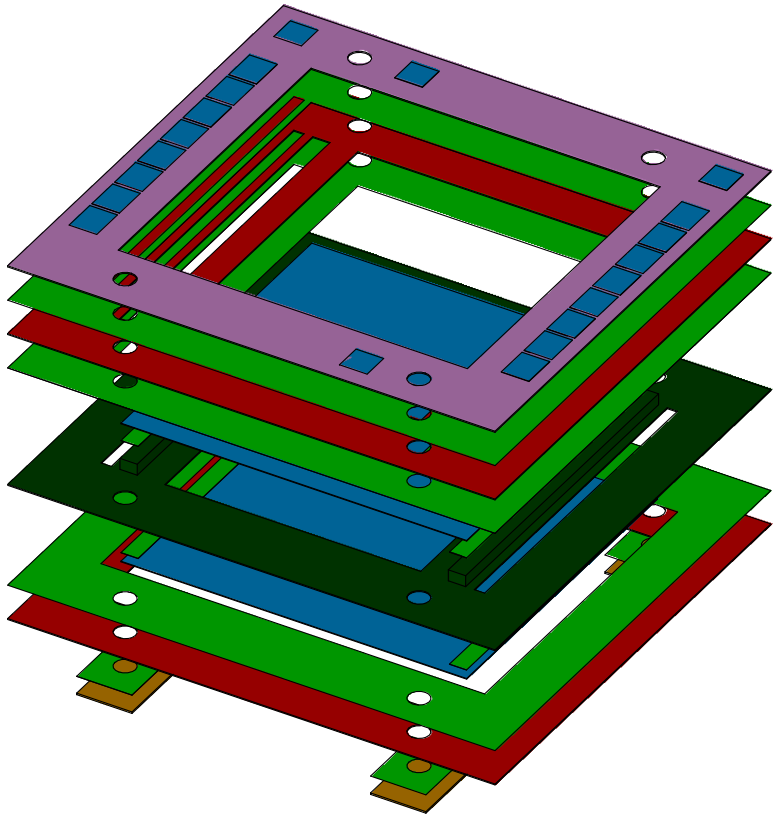


# Design of the 2S Module

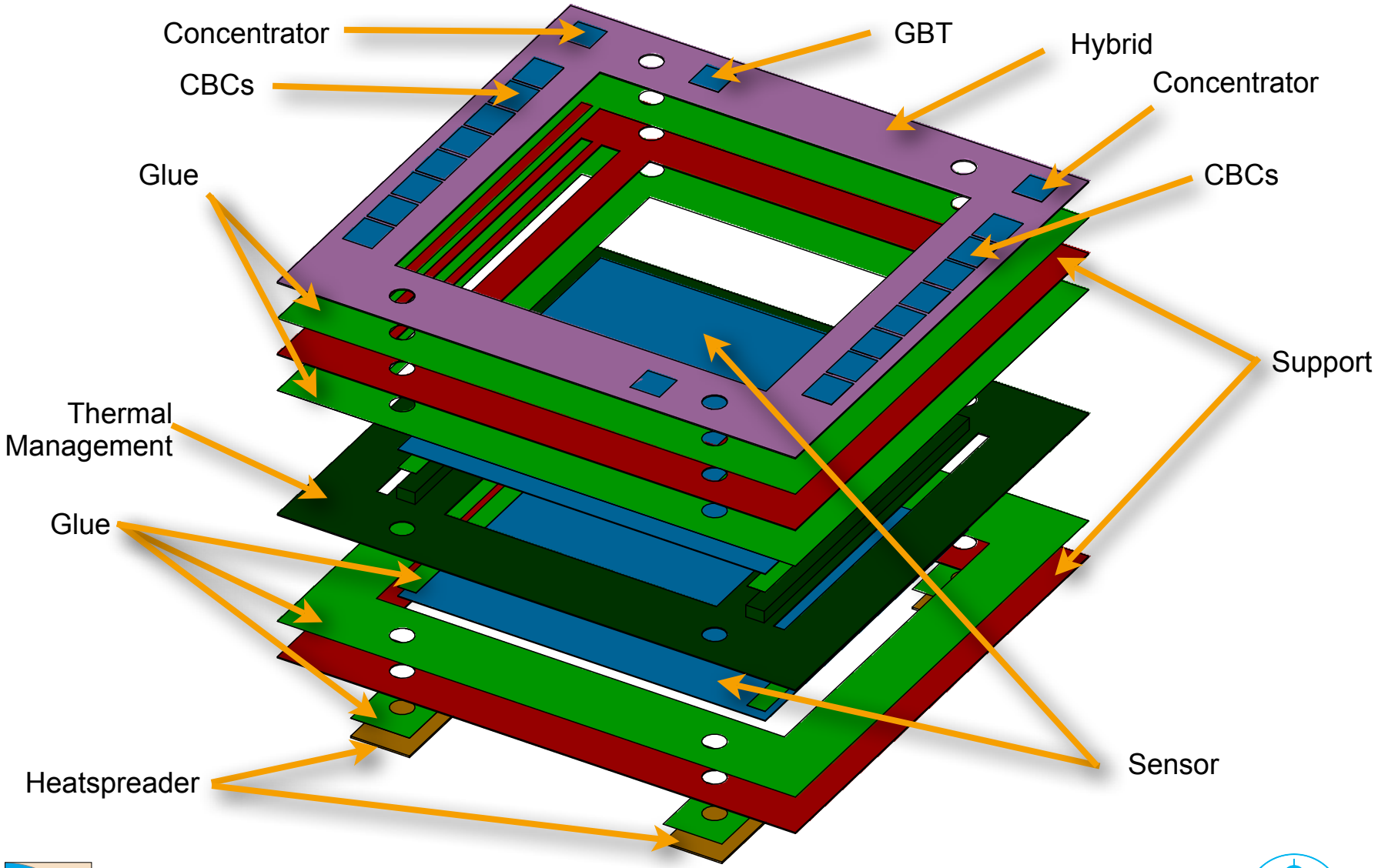




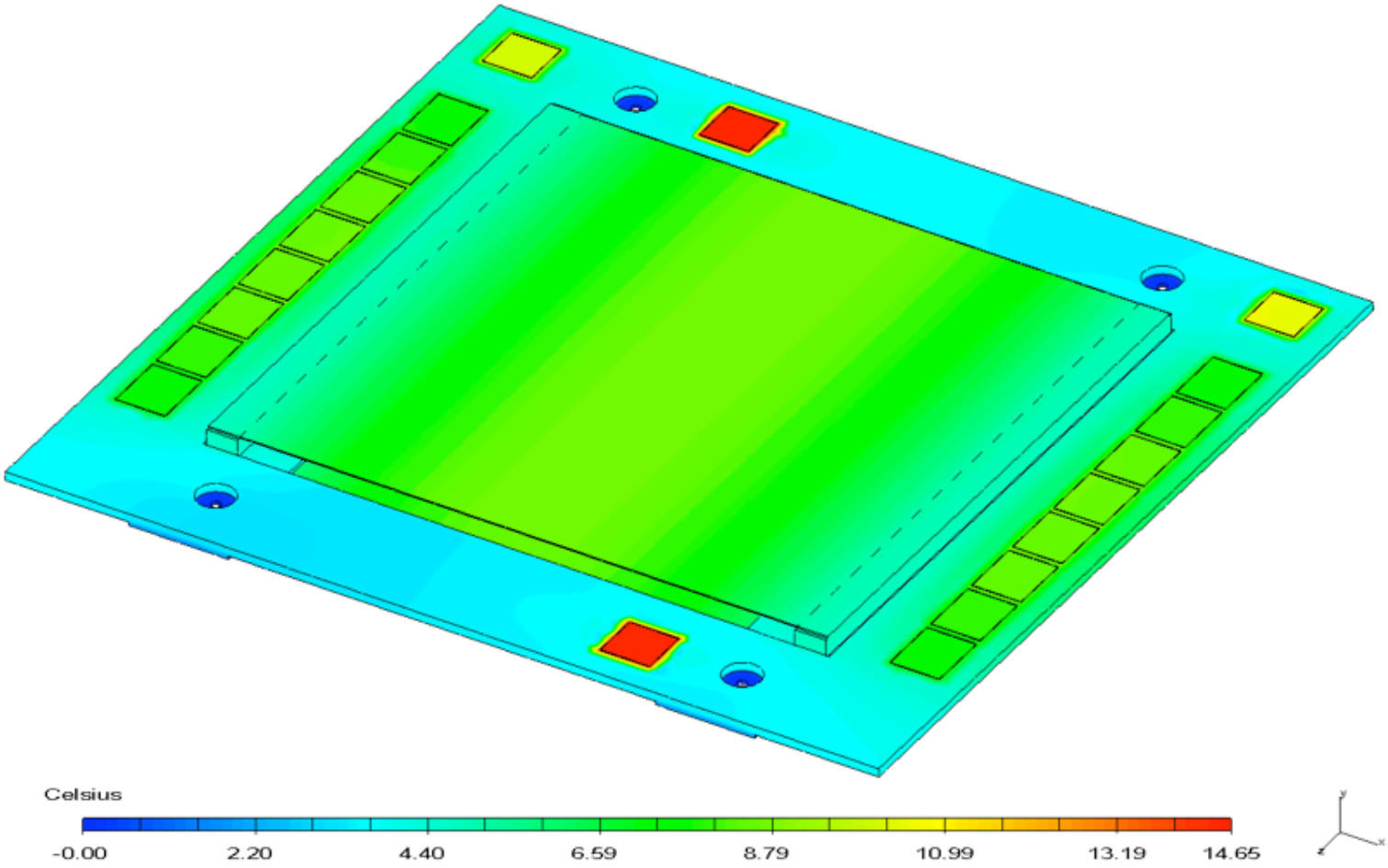


- 2 sensors (10 cm x 10 cm) at a spacing of 1 mm - 4 mm
- 16 CBCs + 2 concentrator chips + GBT + DC/DC converter
- 4 contacts/connections to cooling

# Design of the 2S Module cont.

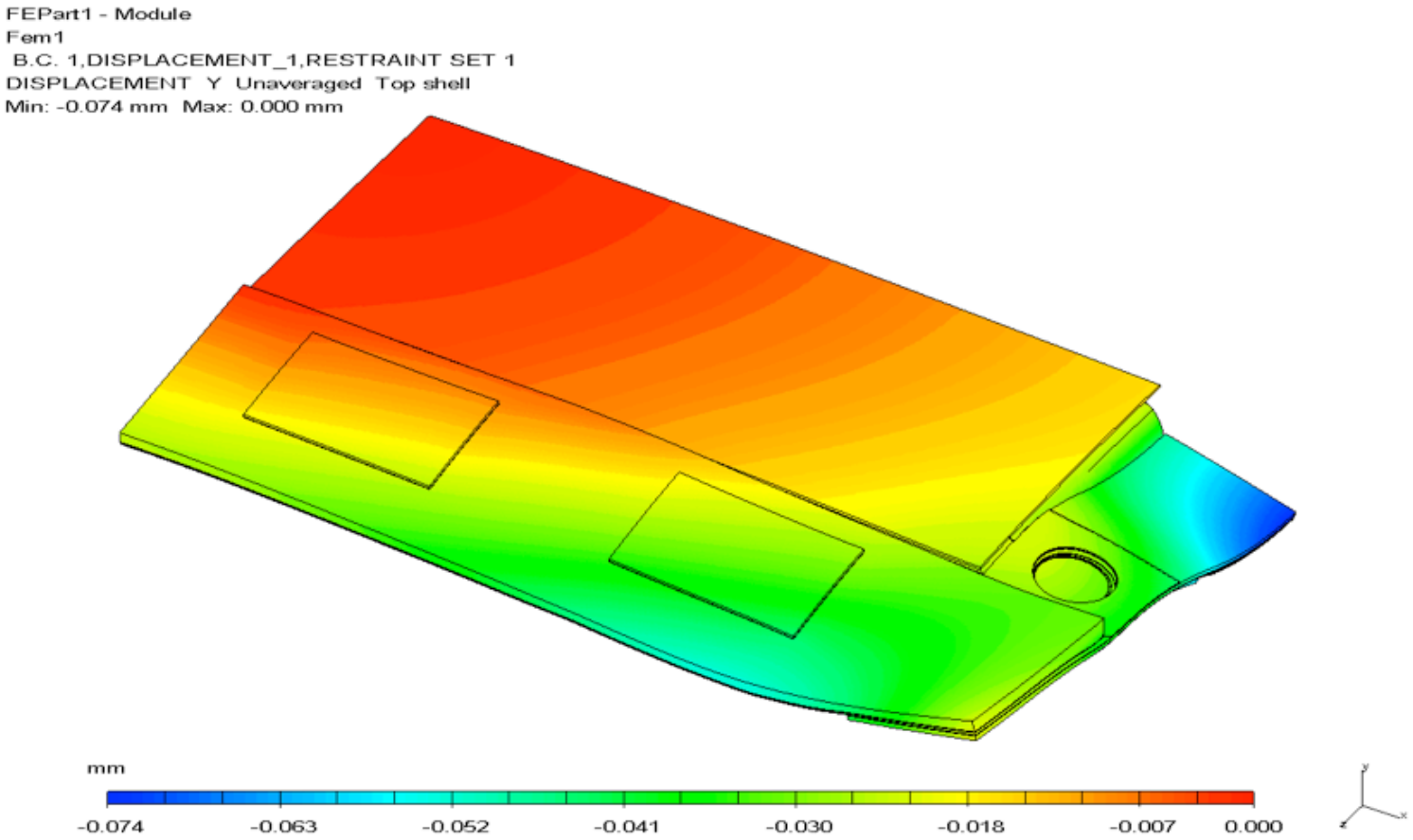


# Preliminary Thermal Finite Element Results




- Power consumption of sensors calculated for 1x10^15 neq/cm^2, 600V Bias and -20°C
- Final numbers for power consumptions of CBCs still needed

# Deformation Results




- Results shown are from a study of the PS module
- Maximum deformation is ~75 um
- Spacing of sensor stays nearly constant - crucial for trigger option

# Summary and Conclusion

- Modules without trigger capability have not been followed for the last year
- Current design work and electronics R&D focuses on 2S and PS
  - PS module has trigger logic integrated into pixel chips
  - 2S module needs extra concentrator chip for triggering

- FEA for the PS module have improved the design
- Currently starting to do the same thing for the 2S module
  - Dedicated workshop on all aspects of the 2S module during the next tracker week (30/01/12)
  - Want to have a balanced (thermal vs. thermo-mechanical vs. material budget) design ready by then
  - Workshop intends to get us to the point at which the design is ready for prototyping

- FEA are a nice tool in the design phase
- However, they are only as good as the input provided, e.g. material properties
- One eventually also needs to measure the thermal performance and deformation of prototypes and the final module designs